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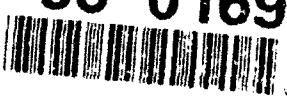
Model Improvement & Study Management Agency

Deputy Under Secretary of the Army (Operations Research)

ARMY STUDY HIGHLIGHTS

VOLUME XIII

DECEMBER 1992



DEPARTMENT OF THE ARMY
OFFICE OF THE UNDER SECRETARY
WASHINGTON DC 20310-0102

29 December 1992

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MEMORANDUM FOR SEE DISTRIBUTION LIST

SUBJECT: Army Study Highlights

Once again, I am proud to acknowledge outstanding work of the Army's analysis community. Publication of the *Army Study Highlights* is a modest recognition of individuals and groups who have carried out fine analytical projects. This visibility provides an opportunity for others to take advantage of examples of good work. The studies chosen for this volume were professionally conducted and of significance to the Army's missions and goals. Selections were based on an evaluation of findings, assumptions, limitations, scope, objectives, and approach.

This thirteenth volume presents twelve quality studies. The volume also recognizes the recipients of the 1992 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis. Two awards were presented this year; the best group and individual authored papers in Army systems and operations analysis were honored.

Thank you for your response to our call. The number and variety of nominations made for an exciting review. The examples of good analysis are very useful for the analysis community. I urge you to make the widest possible distribution of this publication in your organization.

Your suggestions are always welcome. Comments and requests for additional copies of the *Army Study Highlights* should be directed to Ms. Gloria Brown of this Agency, DSN 327-3417, Commercial 703/607-3417.

Eugene P. Visco

Eugene P. Visco, Director
US Army Model Improvement and
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CONTENTS

STUDY GISTS

Abstracts from the Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis 1992 Papers

ACTIVE COMPONENT STRUCTURE REDUCTIONS

-- IMPACTS ON CAPABILITY AND RESOURCES --

THE PRINCIPAL FINDINGS

(1) Under the nominal or "base case" conditions (sequential contingency operations, projected threat, minimal threat modernization, etc.) and fixed forward deployments the Base Force appears able to obtain a "decisive" level of warfighting capability in one but not both contingencies at the eno of the Extended Program Annex (EPA).

(2) If a lesser level of warfighting capability is acceptable (higher casualties, extended time to achieve military objectives), the Army end strength can be moderately reduced after the turn of the century.

(3) The resultant Operational and Sustainment (O&S) savings derived from the reduced force over the planning period were minimal.

(4) Under the nominal conditions and flexible forward deployments the Army appears to be capable of conducting a moderate reduction in force after the turn of the century.

(5) If high casualties, risks, and feasibility issues are ignored, the Army end strength could be further reduced in the long-term.

(6) Total savings during the planning period would be moderate.

THE MAIN ASSUMPTIONS

(1) The Army drawdown will affect both heavy and light forces.

(2) No changes to AOE designs were considered.

(3) The Army will deploy all forces allocated to each contingency if possible.

(4) The forces will operate under current operational concepts.

(5) Nominal conditions assume no modernization of threat forces.

(6) Research, Development and Acquisition (RDA) programs are not affected by reductions in the force structure.

THE PRINCIPAL LIMITATIONS

(1) Force arrivals in theater were based on Army requirements and not projected lift capability.

(2) The study assumed that adequate Combat Support and Combat Service Support (CS/CSS) would be available in theater.

THE SCOPE OF THE STUDY

(1) Illustrates the relationships among casualty levels, warfighting capability, and decisive operations as required by the National Military Strategy (NMS).

(2) Examines the relationship between force size and warfighting capability in the Defence Planning Guidance (DPG) contingencies.

(3) Examines the resource implications of potential reductions.

THE STUDY OBJECTIVES

The objective of this study was to illustrate the risks faced by forces deployed during contingency operations should strength reductions below the Chairman's Base Force occur. Additionally, the study identified the potential budget savings resulting from reduced force levels.

BASIC APPROACH

The basic approach for this study was to identify several potential force levels throughout the planning period and determine the warfighting capability of each force throughout the same period. The analysis portrayed the consequences of deploying U.S. forces at each force level. These results illustrated, given a certain level of risk, the acceptable force levels required throughout the planning period. The potential dollar savings over time at each force level were estimated.

REASONS FOR PERFORMING THE STUDY

This study was commissioned by the Secretary of the Army to assist him understand the relationship between Army force levels and the ability of the U.S. to accomplish the requirements specified in the National Military Strategy.

STUDY IMPACT

This study suggests that cost savings experienced as a result of reductions to the Base Force must be carefully weighed against the increased risk to the capability to achieve the requirements in the NMS.

STUDY SPONSOR

Secretary of the Army
Washington, D.C.

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS

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START AND COMPLETION DATES OF STUDY:

16 September 1991 through 31 March 1992.

CAA	ARMY PROGRAM VALUE ADDED ANALYSIS 94-99 (VAA 94-99)	STUDY SUMMARY CAA-SR-92-10

THE PRINCIPAL FINDINGS of the study were:

(1) The Value Added Analysis study framework, as developed in the VAA Phase I Study, was shown to be useful in evaluating Program Objective Memorandum (POM) issues.

(2) The use of an experimental design and a response surface methodology was found to be an effective means to determine system contribution to combat results.

(3) The Life Cycle Cost Model (LCCM) is a useful tool for providing action officers with detailed cost estimates for candidate POM programs.

(4) The development of a mixed integer programming formulation that allowed consideration of cost/quantity relationships and handles fixed production costs and research, development, test, and evaluation costs explicitly was shown to be an extremely effective method of cost-benefit analysis.

THE MAIN ASSUMPTION of this study is that HQDA needs a responsive method for conducting program tradeoff evaluations which has sound analytical underpinnings.

THE PRINCIPAL LIMITATIONS

(1) The analysis examines the research and development and acquisition appropriations and other selected appropriations as needed to evaluate the major costs and benefits of selected systems.

(2) Only a subset of the available modernization programs were included in the analysis. Selection of the systems evaluated was based on the existence of a requirements document, cost of the program, and the ability to model the system.

THE SCOPE OF THE STUDY included the research, development, and acquisition (RDA) appropriations and other selected appropriations for designated major modernization systems in the FY 1994 and FY 2008 timeframe.

THE STUDY OBJECTIVES were to:

(1) Produce effectiveness measures and feasible acquisition alternatives for major item systems proposed by Headquarters, Department of the Army (HQDA) Long-Range Research, Development, and Acquisition Plan (LRRDAP) within specified total obligational authority (TOA) constraints. The process must measure and analyze the capability of US Army forces to conduct conventional operations in scenarios consistent with the Illustrative Planning Scenarios of the Defense Planning Guidance, Fiscal Year (FY) 1994-1999.

(2) Identify and develop a Value Added Analysis Capability (VAAC) to include all appropriate hardware, software, and interfaces. The VAAC must tap major authoritative Army data bases such as the Total Army Equipment Distribution Program (TAEDP), Force Accounting System (FAS), and the Army Force Cost System (TAFCS).

(3) Identify or develop models and techniques that support the VAA methodology. The VAAC and related models must be capable of operating in a "quick turnaround" environment, defined as 1 week or less.

(4) Conduct a demonstration of the refined methodology and VAAC prior to the building of the 1994-1999 POM.

(5) Continue the refinement and implementation of the VAA methodology for estimating the value of either competing major item systems or management decision packages (MDEPs) to the Total Army Program.

(6) Use the VAA capability to perform analyses to support the POM building process as necessary.

THE BASIC APPROACH of this study was to:

(1) Enhance and expand the analytic approach for program issue tradeoffs developed in Phase I of the VAA study effort.

(2) Develop a VAAC for implementing the methodology to include software modules where appropriate.

(3) Demonstrate the VAAC using issues from the 94-99 POM issue cycle.

THE REASON FOR PERFORMING THE STUDY was to provide the Director for Program Analysis and Evaluation, and the Deputy Chief of Staff for Operations and Plans (DCSOPS) an analytical methodology and capability to support the development of a balanced and effective Army Program.

STUDY IMPACTS

(1) This study developed and implemented a comprehensive cost-benefit analysis methodology for comparing complex modernization alternatives in support of Army leadership decisions at key materiel development and acquisition milestones.

(2) The VAA methodology was used to support decisionmaking throughout the Long-Range Research, Development, and Acquisition Plan (LRRDAP), 1994 - 2008, review process. This effort culminated in the evaluation of Army modernization plan alternatives which were presented at the Chief of Staff, Army Offsite Modernization Review.

(3) The VAA methodology was called upon to provide a series of analyses to support the proceedings of the Executive Select Committee on Modernization. VAA was used for evaluating relative force effectiveness under several alternative funding levels.

(4) The Secretary of the Army directed additional VAA excursions to evaluate several modernization issues. The results were used to support key acquisition and programming decisions.

THE STUDY SPONSORS are the Director for Program Analysis and Evaluation (DPAE), Office of the Chief of Staff, Army, and the Technical Advisor, Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS), Headquarters, Department of the Army (HQDA).

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS

US Army Concepts Analysis Agency, 8120 Woodmont Avenue, Bethesda, MD 20814. Principal authors: LTC Robert R. Koury; LTC Andrew G. Loerch.

DTIC ACCESSION NUMBER: DA332012.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSR, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

START AND COMPLETION DATES OF STUDY: Sep 91 - Jul 92.

CAA — Concepts Analysis Agency, United States Army	ARMY STRATEGIC FORCE ARCHITECTURE (ARSTAR) (U)	STUDY SUMMARY CAA-SR-92-9

THE PRINCIPAL FINDINGS

(1) The study identified and evaluated over 30 possible conflict environments or cases that could require the use or threatened use of US military forces. Proposed cases were grouped by geographic region due to the nature of the cases and the regional approach of the National Military Strategy. The five regions considered in the assessment were Europe, the Middle East and the Horn of Africa, Asia, Latin America, and Subsaharan Africa.

(2) The cases identified were grouped using a two-dimensional typology to identify the most compelling cases. The analytical efforts would then focus on the most important cases. The first dimension grouped cases using the standard Army conflict spectrum (major regional contingency, lesser regional contingency, low intensity conflict, foreign assistance, etc.). This dimension ensured that cases with similar force demands received appropriate consideration. The second dimension forecasted the role (if any) that the United States might play in each identified crisis. This part of the methodology was most crucial since US roles in the selected cases would drive force requirements. Due to the constrained resource environment, only the most compelling cases could be selected for force planning purposes.

(3) The prospective threat in each case scenario was evaluated under different scenario assumptions (e.g. mobilization time). In evaluating the force requirements for each case, ARSTAR methodology considered the effect on force structure of a variety of scenario assumptions which generated different threat ranges and risks.

(4) Force requirements for the most compelling cases were evaluated over a range of adaptive planning objectives. The adaptive planning concept recognized that more ambitious objectives would require a larger military force. The adaptive planning objectives used in ARSTAR were: Deter, Defend, and Overwhelm (these objectives are defined in Chapter 5 of the study report). An estimate of the force requirement for each adaptive planning objective was established during the force modeling stage using computer-simulated campaigns and other analytical techniques.

(5) Force requirements were integrated into a single cohesive force using two principal strategy criteria based upon National Military Strategy.

(6) Active and Reserve Component divisional and manpower requirements were evaluated for each of the two principal integrating strategies.

THE MAIN ASSUMPTION of the study was that the cases selected for analysis were representative of the conflict environments that the Army may face in the future.

THE PRINCIPAL LIMITATION was that the study was completed prior to the publication of the FY 1994 - 1999 Defense Planning Guidance (DPG). Study results are being updated in the ARSTAR 92 Study which is focusing on the DPG scenarios.

THE SCOPE OF THE STUDY included force requirements for the Active and Reserve Components of the Army.

THE STUDY OBJECTIVES were to: (1) formulate a strategic force planning process for the Army that meets the needs of a rapidly changing security environment; and (2) outline the initial design resulting from such a process. The ARSTAR design could then be compared with the Chairman's Base Force as an independent Army assessment of requirements.

THE BASIC APPROACH used in this study was to:

(1) Perform an exhaustive literature search to evaluate other force design efforts, threat assessments, force requirements, and other factors impacting force design

(2) Assess and evaluate the impact of the new National Military Strategy (NMS) on force design requirements

(3) Assess and evaluate the most compelling conflict scenarios from a comprehensive list of possible conflict scenarios

(4) Assess and evaluate the force requirements for the most compelling scenarios under varied assumptions to determine the force requirements for each scenario using both static and dynamic assessments

(5) Integrate the various regional requirements into a single cohesive force structure using the priorities and guidance from the National Military Strategy.

THE REASON FOR PERFORMING THE STUDY was to respond to the chaotic change that has characterized the political-military setting of the last few years. The pace and the effects of such revolutionary change demanded a fundamental reassessment of the Army's basic force structure planning process. The Cold War planning process which built an Army primarily to contain the forces of the Soviet Union within the single, dominant global planning scenario, was clearly unsuitable in the evolving strategic environment. To cope with this fundamentally changed planning environment, the War Plans Division of the Army's Deputy Chief of Staff for Operations and Plans (DCSOPS) requested in August of 1990 that the US Army Concepts Analysis Agency (CAA) conduct this review of Army force planning.

STUDY IMPACT (As evaluated by the DCSOPS, Chief of War Plans)

ARSTAR represents a significant step forward in the force design process. In the short term, ARSTAR provides a basis for the allocation of forces in the Total Army Analysis (TAA) process. In the midterm, it provides a means for the DCSOPS to evaluate variants/reductions in the Base Force as it is applied against a particular regional contingency or combinations of contingencies. Over the long term, ARSTAR can assist DCSOPS as an important component in its work to develop and analyze changes to the Army Force Structure.

THE STUDY SPONSOR was the War Plans Division of the Deputy Chief of Staff for Operations and Plans, Headquarters, Department of the Army.

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DTIC ACCESSION NUMBER: To be provided.

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START AND COMPLETION DATES OF STUDY: Aug 90 - Mar 92.

CAA	COUNTERDRUG TRANSPORTATION ANALYSIS PROGRAM (XDTRAP)	SUMMARY CAA-MR-92-39

THE PRINCIPAL FINDINGS

(1) When interdiction operations are supported by high-tech interdiction assets, particularly airborne early warning (AEW) platforms, narcotraffickers cease air transshipment operations and focus increased attention toward land and riverine operations as a means to move cocaine base to cocaine producing labs outside of the Chapare.

(2) When counterdrug operations employing AEW assets are underway, base production continues, but transportation cutbacks result in increased storage requirements.

(a) Shorter or intermittent AEW operations do not result in significant production disruptions since traffickers have sufficient opportunity to reduce built up inventories with increased base movements after AEW operations have ended.

(b) Longer AEW operations force traffickers to rely more heavily on less effective transportation means to move cocaine base out of the region. This results in large build ups of stored base which will spoil if maintained beyond its useful shelf life, or force the production of *agua rica* (cocaine base suspended in liquid form), a capability many regions have not yet acquired.

THE MAIN ASSUMPTIONS

(1) Coca production

(a) The Chapare Valley produces approximately 85 percent of the total Bolivian coca harvest.

(b) There are approximately 25,000 hectares in the Chapare that are growing mature coca plants used for illicit cocaine base production. The Drug Enforcement Agency's (DEA) best estimate of average annual yield is 2.7 metric tons of dry leaf per hectare. Differences in coca plants and growing conditions yield a range of conversion factors when computing cocaine paste and base production quantities. Using DEA's accepted mid-point conversion factors, converting hectarage to base translates to 247.6 metric tons of cocaine base production in 1991.

(c) It was assumed that weather cycles are sufficiently stable within the Chapare Valley such that annual growth yields can be sufficiently reduced to daily averages.

(2) Trafficking Out of the Chapare

(a) During normal trafficking operations, traffickers will use airborne assets to transport cocaine base out of the Chapare approximately 90 percent of the time. They move base on the roads approximately 8 percent of the time and on the rivers about 2 percent.

(b) Historical records show that the average outbound load for a typical drug running aircraft is 300 - 350 kilograms (kg); for land traffic, the average is 45 kg; and the average estimate for riverine traffic is 35 kg.

(c) Traffickers will not risk flying an airplane when only a partial load is available for shipment.

(d) The maximum number of outbound flights are limited to five per day. This is to alleviate unrealistic situations where the model's logic might try to ship large inventories of available cocaine products during a single day.

(3) It is assumed that historical averages from previous counterdrug operations provide an accurate basis for predicting success during future operations.

THE PRINCIPAL LIMITATIONS

(1) Only a subset of the various aspects of the narcoindustry were included in the analysis. The primary focus during XDTRAP development was on the production and transportation of illicit cocaine. Money flow and other business aspects relating to drug trafficking were not included due to time limitations.

(2) The XDTRAP production algorithms include the capability to model seasonal adjustments in coca leaf cultivation. However, these algorithms factored in the cumulative impact of these adjustments to reduce and simplify the number of computations and decrease response time. This will *not* be a limitation in follow on models.

THE SCOPE OF THE STUDY

(1) Situation: XDTRAP was developed to support SOUTHCOM's Counterdrug Modeling and Wargaming (CDMWG) initiative held at Hurlburt Field, FL, during the period 27-30 April 1992. Prior to the beginning of Move 1, it was decided to refocus game play to examine planning aspects of the ongoing operation, GHOST ZONE, that was underway in Bolivia.

(a) The first move initiated during the CDMWG proposed investigating how operation GHOST ZONE would extend through D + 75.

(b) The second move extended the operation GHOST ZONE through D + 180.

(c) The third move examined the implications of an augmented US and Bolivian effort to close down cocaine base transportability out of the Chapare.

(2) Annual harvest and production estimates were gleaned from a message from the American Embassy, La Paz, Bolivia, 26 Feb 92, reporting on estimates of the importance of coca in the Bolivian economy in 1991.

STUDY IMPACT

(1) The direct application of this model provided quick-response assessments of the effects of "action - reaction" initiatives proposed by the host country and the narcotrafficker teams during the CDMWG initiative. Model results were used to estimate the expected disruptions in trafficking activities resulting from interagency counterdrug operations. This had a direct impact on the operational planning for Operation GHOST ZONE.

(2) Analysts and game adjudicators used XDTRAP to evaluate the effects of a multitude of counterdrug responses. This contributed to the timely assessment of the effective application of alternative methods for employing scarce resources.

(3) The XDTRAP modeling strategy and analytical results were briefed to the CINCSO, GEN Joulwan, as part of the CDMWG After Action Review.

THE STUDY SPONSOR

Director, United States Southern Command (USSOUTHCOM), Washington Field Office.

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DTIC ACCESSION NUMBER: To be provided.

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START AND COMPLETION DATES OF STUDY: Apr 92 - Jun 92.

(3) Predictive declines in transportation capability are computed based on previously reported US supported counterdrug operations.

(4) The area of operations was limited to the Chapare Valley of Bolivia.

THE STUDY OBJECTIVES

(1) Estimate the average daily production and transportation capabilities of narcotraffickers within the Chapare Valley.

(2) Estimate expected disruptions in narcotrafficking activities resulting from interagency counterdrug (CD) operations.

THE BASIC APPROACH entailed developing a spreadsheet model using Microsoft Excel to perform the calculations pertinent to the analytical requirements. The XDTRAP Model was developed in three primary sections as follows:

(1) The first section represents production and transportation during normal trafficking operations. Annual crop yields obtained from open source references were converted to daily estimates. Consideration was given to harvesting surges that might be experienced following rainy seasons. Daily harvests can then be converted to coca product estimates in the form of paste, base, or cocaine. Based on product accumulations, transportation requirements are computed based on expected trafficker resource availability in the form of air, land (roads), or riverine (water) assets.

(2) The second section of the model estimates interdiction effectiveness against trafficking practices given that a counterdrug operation is ongoing. Here the modeler is able to hypothesize "what if" situations by changing variables that represent how traffickers will react to fluctuating levels of pressure. The modeler also has the ability to change how traffickers will attempt to transport products out of the region.

(3) The third section of the model contains a listing of the control variables used in the computation of active components of the other sections of the program. XDTRAP is set up in such a way that user inputs are made through the use of these control variables as specific situations or areas being investigated. This also contributes to the ease of performing sensitivity analysis by having all of the major input variables consolidated in one section of the model. Also, data collected from previous counterdrug operations, was the primary source of the input parameters used to predict effectiveness during the current effort.

THE REASONS FOR PERFORMING THIS STUDY

(1) Develop a macro model of the production and transportation capabilities of narcotraffickers within the Chapare Valley of Bolivia, providing analytical support to SOUTHCOM's Counterdrug Modeling and Wargaming (CDMWG) Initiative Phase II held at Hurlburt Field, FL, 27-30 April 1992.

(2) Provide estimates of the effects of "action-reaction" initiatives proposed by the host country support team and the narcotrafficker team (Red Team) during the CDMWG.

DESIGN AND EVALUATION OF 2+2+4 RECRUITING EXPERIMENT

REASONS FOR PERFORMING THE STUDY

The 2+2+4 recruiting option is a tool that can help the Army attract high-quality young people during difficult recruiting periods and help channel trained, experienced personnel into the reserve force. Under the 2+2+4 recruiting option, recruits receive an $8,000 Army College Fund (ACF) benefit if they choose a two-year active-duty tour in selected noncombat occupational specialties, with an additional commitment of two years in the Selected Reserve and four years in the Individual Ready Reserve (IRR).

The origins of the 2+2+4 program lie in the policy debate surrounding the cost-effectiveness of two-year enlistment option in the late 1980s. The use of short terms was criticized as increasing training costs, since more trained recruits were required to produce a given number of manyears of service. In 1988, Congress prohibited the payment of ACF benefits to two-year recruits, except in the case of combat specialties. In early 1989, the Army and RAND developed the 2+2+4 option to alleviate concerns about the cost-effectiveness of previous two-year options. First, the option is restricted to specialties with short training times, and recruits are required to serve two years in the active Army *after* completing basic and Advanced Individual Training. Second, the reserve commitment enhances the return on the active-duty training investment.

With congressional permission, the Army and the Office of the Secretary of Defense conducted an experiment to evaluate the cost-effectiveness of the 2+2+4 program. The test was conducted from July 1989 through September 1990. RAND was given the leading role in designing the experiment and evaluating its results.

THE STUDY OBJECTIVES

1. Develop an experimental test design to measure the effectiveness of 2+2+4 as a recruiting tool, including a methodology for assigning individuals persons and recruiting battalions to test cells.
2. Monitor test implementation and enlistment rates under the experimental and control programs during the test period.
3. Analyze whether the program attracts new recruits to the Army. Estimate the effects of the program on "buydown" from longer to shorter terms of service and on "buyover" from other skills to those skills eligible for 2+2+4 option.
4. Examine longer-term effects of the program on requirements for active-duty training, availability of prior-service recruits to the reserves, and recruiting and training activities needed to sustain the reserves.

STUDY SCOPE

At this point, the design and enlistment portion of the experiment have been completed. Follow-up analysis will be conducted in a separate project for fiscal year 1993 to track the affiliation rate of program participants with reserve units.

THE BASIC APPROACH

1. To assess whether the test program led to an overall market expansion, we employed a *geographic experiment*. Under the geographic plan, matched sets of areas were assigned to different program cells. This made it possible to compare the overall numbers of enlistments in test and control areas.

2. The design also relied on a *job-offer experiment* that randomly assigns qualified Army applicants to varying program conditions. This portion of the design made it possible

to estimate how eligibility for the 2+2+4 program affected the decision of qualified applicants to join the Army and their subsequent skill and term-of-service choices. Individuals were randomly assigned to control or 2+2+4 eligible groups; thus, we were able to obtain estimates of program effects on skill and term-of-service choices.

THE PRINCIPAL FINDINGS

1. The 2+2+4 experiment has demonstrated that substantial numbers of recruits are willing to commit for two years in the Selected Reserve to obtain ACF benefits. During the 15-month experiment, the Army wrote over 6,800 2+2+4 enlistment contracts, about 8 percent of all high-quality sales during the test period.

2. The 2+2+4 program expanded the market for high-quality enlistments by about 3 percent. Considering that this program is a modest enhancement to a well-established ACF program, this effect is a promising result and about the size that was anticipated.

3. The analysis indicates that the 2+2+4 program did not shift a large number of recruits away from longer terms of service. The share of recruits choosing a two-year enlistment rose from 21 percent among persons in the ineligible test cell to 24 percent in the eligible cell, but the increase in two-year enlistments was primarily driven by a reduction in three-year enlistments, with no change in four-year enlistments. The potential adverse effect of the program on average term of service is further mitigated by the fact that program participants will serve a two-year term plus training time or about two-and-a-half years on active duty.

4. The program did channel recruits into those hard-to-fill noncombat skills that participated in the 2+2+4 program. The share of recruits in participating skills rose three percentage points in the test eligible cell as compared with the ineligible cell, representing a 16 percent increase in enlistments in the participating noncombat skills.

5. The program is likely to provide substantial reserve benefits, since two-year enlistees are much more likely to participate in the reserves than four-year enlistees. Historically, about 45 percent of two-year enlistees join the reserves—a rate 10 to 15 percentage points higher than for other high-quality enlistees. The 2+2+4 program provides extra incentives to join the reserves; thus, we anticipate the program will provide a substantial payoff in meeting future reserve manning requirements.

THE MAIN ASSUMPTIONS

1. The program was offered in skills with both active and reserve component needs. The program benefits are premised, in part, on subsequent reserve vacancies, particularly in the trained active-duty skill.

2. The program was modest-sized relative to overall Army accessions; as a result, two-year enlistments did not impose an excessive strain on training resources.

THE PRINCIPAL LIMITATIONS

1. Historical reserve participation rates may not be a reliable measure of how likely 2+2+4 participants are to join the reserves. We suspect that the historical evidence will be a lower bound on the likely participation rate, but a follow-up analysis is warranted to compare the actual reserve participation rates of individuals in the 2+2+4 program with similar Army entrants in the same cohorts.

2. The military drawdown and force restructuring may have implications for measuring the effectiveness of the program in a "steady-state" environment. In the next few years, the reserve vacancies and the skill composition of those vacancies may not be representative of the longer-term demand of reserve units for recruits with prior service experience.

STUDY IMPACT

1. The Army believes that the program has been a success and is encouraging OSD and the Congress to make the 2+2+4 program a permanent part of their recruiting environment. At this point, OSD has been reluctant to adapt the program without a follow-up analysis of reserve participation by recruits in the 2+2+4 program.

2. The Senate Armed Services Committee has encouraged the services to adapt programs like the 2+2+4 program, because it believes the program will help channel trained personnel into the reserves.

STUDY SPONSOR

The study was sponsored by the Deputy Chief of Staff for Personnel.

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Presently not available.

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START AND COMPLETION DATE OF THE STUDY

January 1989–December 1991

Effects of Signature Reduction on Smart Weapons Performance

STUDY GIST

THE PRINCIPAL FINDINGS

(1) Findings and conclusions are classified. Volumes II, III, and IV are available upon request.

THE MAIN ASSUMPTION

(1) What can be seen, can be hit. What can be hit, can be killed.

(2) Organizations throughout Department of the Army and Department of Defense (DoD) possess knowledge of signatures and how they work, however, these organizations do not have established guidance or references as a resource.

THE PRINCIPAL LIMITATIONS

(1) Solving the issue of temperature profiles, solar loading and solar reflection and spectral emissions for vehicle characteristics that is agreeable to all participating parties in the study.

(2) Identifying sensor technologies from industrialized nations and republics.

(3) Effective evaluation of millimeter wave (MMW) signature reduction techniques to establish signature requirement to resolve issues within the community.

THE SCOPE OF THE STUDY

(1) Data was collected on generic smart weapons capabilities and included the investigation, quantification, and description of the phenomenology of infrared (IR) and MMW seekers/sensors to autonomously acquire and track targets. In addition, threat smart weapons data was collected and analyzed for performance assessment. The assessment focused on adversary, allied and the third world's capabilities to produce and/or field various types of IR and MMW smart submunitions and sensor-driven acquisition systems in the 1995-2004 timeframe.

THE STUDY OBJECTIVE

(1) To provide insights on, and quantify the amounts of and types of, Infrared IR and MMW signature reduction necessary to protect ground systems by reducing the effectiveness of current and future threat smart weapons in realistic/cluttered battlefield environments.

THE BASIC APPROACH

(1) Address issues of specifying allowable IR and MMW signatures for U.S. armored, combat support and combat service support vehicles.

(2) Ability to remain undetected by threat smart weapons.

(3) Provide quantifiable and traceable IR and MMW signature thresholds for U.S. vehicles, such that the use of smart weapons by an enemy force will remain ineffective.

THE REASONS FOR PERFORMING THE STUDY:

(1) Standardize the methodology, assumptions, and the analytical process for quantifying the ground target signature effects on smart sensor systems.

THE STUDY IMPACT

(1) Results of this effort will be used to determine what levels and types of IR and MMW signature reduction are required to significantly degrade the performance of IR and MMW munitions and IR acquisition systems in a realistic environment.

THE STUDY SPONSOR

(1) Sponsored jointly by the Deputy Chief of Staff for Operations (DCSOPS), Combined Arms Command-Combat Development (CAC-CD), U.S. Army Laboratory Command (LABCOM), Low Observable Technologies Office (LOTA) with direction and coordination by the AMC Smart Weapons Management Office.

THE PERFORMING ORGANIZATION AND PRINCIPAL AUTHOR(S)

(1) The AMC Smart Weapons Management Office is the performing organization providing direction and coordination. Principal authors were DCSOPS, CAC CD, LABCOM, and LOTA.

THE DTIC ACCESSION NUMBER OF FINAL REPORT

(1) A DTIC accession number is not assigned.

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THE START AND COMPLETION DATE OF STUDY

(a) Start Date of Study: September 1991

(b) Completion Date of Study: August 1992

ESTIMATING COSTS OF CHANGES IN ARMY INDIVIDUAL SKILLS TRAINING

REASONS FOR PERFORMING THE STUDY

Responding to mission, organization, and budget changes, Army policymakers are considering several alternative training strategies that might reduce the resources used for individual training. For example, various proposals advocate:

- Increased on-the-job training in lieu of formal "schoolhouse" training;
- Increased use of training aids, devices, and simulators, or other technology to substitute for the more expensive actual weapon systems;
- Training in civilian facilities to substitute for selected military training courses;
- Simply reducing the length of training courses.

To ensure that such alternative methods will reduce the costs of training, the Army needs a way of estimating how changes to current training approaches will alter the resources and costs required to train in specific instances.

A key problem in determining the potential savings from such changes is that the Army does not now have methods that provide detailed estimates of certain training costs, especially for specific courses, where many proposed changes in individual training will take place. Although the Army has general cost estimates associated with manpower, equipment, and base operations, these costs are estimated in such a way that does not permit detailed analysis of the resources required to produce and execute a change in training strategy in a given course.

THE STUDY OBJECTIVES

This study describes a method to formulate estimates of the changes in course costs, given changes in training strategy. This method—the Training Resource Analysis Method (TRAM)—examines how a change in training strategy would alter training and support activities and aggregate resource use. TRAM has three objectives: (1) evaluate training options; (2) assess the effects of alternative implementations of training options; and (3) estimate the changes in costs and savings.

STUDY SCOPE

TRAM supports a detailed job analysis procedure that suggests training options and alternative implementation methods encompassing content, location, and timing of the training, as well as training technologies and media. TRAM is also used to cost the various training options that are produced by the job analysis. This combined approach not only analyzes alternatives but also generates promising alternatives to analyze. We demonstrate the use of the method for two courses, an officer course and an enlisted course.

THE BASIC APPROACH

TRAM is a five-step process to cost alternative training strategies for an individual course.

1. *Define and Specify Baseline (the Current Course) and Alternatives.* This step formulates the costing problem.
2. *Analyze Changes in Key Activities.* This step identifies how activities change for the affected organizations, based on changes in workload—a necessary precursor prior to quantifying resource changes.
3. *Analyze Specific Changes in Resources: Manpower, Equipment /Materiel /Supplies, and Facilities.* Resource consumption is driven by various activities;

this step shows how the resources will change based on changes in activities generated by the alternatives.

4. *Calculate Costs and Savings of Alternatives.* Cost factors are applied to specific resource changes for the various alternatives to determine cost and savings changes.
5. *Present Results in Meaningful Context—Identifying Cost Flows, Trade-offs, and Risks.* Once costs are identified, the final step is to interpret the cost changes for the decisionmaker.

THE PRINCIPAL FINDINGS

1. The TRAM approach to costing alternative training strategies emphasizes defining the training alternatives and examining the *changes* in activities and resources by using a balance sheet. This is a very useful tool in analyzing training alternatives, because without such a structured approach, important resource changes—including indirect effects—may be omitted and critical assumptions may remain unexplored. These omissions result in cost conclusions that are unrealistic and contribute little to informing training decisions.

2. The TRAM method improves decisionmaking by linking costs to the specific alternatives being evaluated. By completely documenting and qualifying the cost results, TRAM helps ensure that appropriate conclusions about the costs of decisions are made. By linking costs and training decisions, TRAM facilitates identification and investigation of cost trade-offs and makes it possible to ask "what if" questions. TRAM also allows new alternatives to be uncovered. Areas of uncertainty highlighted in the process may be examined and assumptions about the implementation of an alternative may lead to the creation of additional options that explore alternative ways to do business.

3. TRAM can provide important insights at each of the five steps discussed above.
   - *Definition of Problem:* With TRAM, alternatives can be specified in more than just one way—depending on the assumptions about implementing that alternative. This is important because the Army has considered a very few ways to implement broadly defined strategies, such as distributed training.
   - *Activity Analysis:* With TRAM, activities, resources, and costs can be tracked on a course basis, something the current financial systems do not do. This is important because the courses and their attendant resources "drive" the costs for the school. In this period of budget reductions and cost cutting, the Army increasingly needs to analyze individual course costs, because decisions about the instructional methods, course length, and class size have critical cost consequences.
   - *Resource Analysis:* With TRAM, the relationships between changes in support workload and required resources can be better defined; currently, many of the relationships are not complete or are inadequately defined. TRAM makes it possible to quantify how changes in training affect these functions and to identify opportunities for greater efficiencies.
   - *Calculation of Costs:* Resources frequently have more than one cost factor. As a result, cost analyses need the flexibility to use different cost values. With TRAM, these factors can now be used consistently and, as a result, analysts can know which factors to use.
   - *Costs in Context:* A significant portion of training resources devoted to training support and base operations functions are insensitive to course reductions and changes in instructional methods. Without other major changes in training—such as consolidating occupational specialties, facilities, and installations—savings in training costs may be at the margin. It may be true that some savings accrue by distributing training to fill units, but there is a point of maximum absorption for the units. At this

point of maximum absorption, investment requirements for distributed training infrastructure support will increase significantly. TRAM helps decisionmakers interpret these cost changes

THE MAIN ASSUMPTIONS

1. The Army must accomplish its training missions with fewer resources than it is accustomed to having.
2. The constraints on resources mean the Army must consider several ways of implementing alternative training strategies to balance the savings against the potential costs in capability and effectiveness.
3. Since costs are not identified at the course level of detail, current resourcing standards are a reasonable proxy for the consumption of resources at this detailed level.

PRINCIPAL LIMITATIONS

1. TRAM is a first step in analyzing the cost behavior of training activities. By employing TRAM, we have identified some important structural determinants of training costs, such as resourcing policies and formulas, patterns of resource utilization, and relationships among activities. However, the scope of TRAM needs to be broadened and other determinants of training costs, which include more training organizations and additional Army discretionary policies such as the mix and variety of courses at training installations, need to be examined.
2. The quality of the cost data used in the analysis is sometimes suspect.

STUDY IMPACT

1. TRADOC is planning to use the method to train course developers on the cost consequences of their decisions.
2. TRADOC has proposed using the costing method in its courses at the Army Management Logistics College.

STUDY SPONSOR

This study was sponsored by the Office of the Deputy Chief of Staff for Training, U.S. Army Training and Doctrine Command.

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START AND COMPLETION DATE OF THE STUDY

Fall 1989–Fall 1992

STUDY HIGHLIGHTS

1. Study title: Hazardous Materials Tracking System Analysis.

2. Principal findings:
   a. Identified data elements required for Hazardous Materials (HAZMAT) tracking, management and Federal reporting purposes.
   b. Identified existing sources for many of the required data elements. The majority of the data required is inventory related and can be obtained from supply Standard Army Management Information Systems (STAMIS). A HAZMAT tracking system could be developed which would avoid significant automation and human resource costs by using existing STAMISs.
   c. Concluded that cataloging policy and coding hamper the tracking of HAZMAT through the supply pipeline (depot, installation, direct support unit, user, Defense Reutilization and Marketing Office.)
   d. Determined that HAZMAT Management Program policy is not promulgated in supply policy.
   e. Identified significant shortfalls in the Army's implementation of the DOD Hazardous Material Information System.

3. Main assumptions:
   a. A single standard Army system will improve HAZMAT management and reduce DA-wide expenditures on multiple stand alone systems.
   b. Current Federal exemption of many environmental federal, state and local laws are likely to be eliminated and increase Army's need for a HAZMAT tracking and management system.

4. Principal limitations:
   a. The study addressed only the procurement, receipt, and storage actions of HAZMAT management and did not consider tracking the consumption or waste phases.
   b. Study is limited to Supply Classes II (clothing, tool sets, etc.), III (package petroleum products and chemicals), IV (construction material), VIII (medical material), and IX (repair parts). Classes I (rations), III (bulk product), V (munitions and explosives), and VII (end items) are excluded.

5. Scope of the study:
   a. Identifies and summarizes all current Federal and DoD legislation, policy and regulations concerning HAZMAT and identifies types of state and local requirements.
   b. Identifies Army policies and procedures for management and tracking of HAZMAT. Recommends improvements to identified shortfalls.
   c. Summarizes existing Army and non-Army HAZMAT/HAZWASTE management initiatives.
   d. Recommends a system concept and a proposed functional description for a standard Army HAZMAT tracking and management system that uses data resident in existing supply STAMISs.

e. Recommends changes to the Army's HMIS implementation procedures and to the DLA managed HMIS.

6. Study objectives:

a. To delineate necessary policy changes to insure proper supply management of HAZMAT.

b. To determine a HAZMAT tracking and management system development approach.

7. Basic approach:

a. Review Army policies and procedures and methodology for management and tracking of HAZMAT.

b. Determine current and expected HAZMAT tracking and reporting requirements.

c. Assess Army Plans, studies and programs to determine HAZMAT tracking goals and initiatives.

d. Assess other prototype or existing HAZMAT tracking systems.

f. Recommend policy changes and determine system development approach.

8. Reasons for performing the study: Developing environmental laws and regulations concerning HAZMAT have increased installation and unit commander liabilities. The Army does not have a standard system to identify and track HAZMAT thorough its material life cycle, or a standard management system to provide commanders with necessary policy and data to make environmentally sound material decisions. HQDA does not have the capability to answer questions regarding total Army HAZMAT procured and used, and HAZWASTE generated. Unique systems which do not effectively meet these requirements are being proliferated.

9. Study Impact: This study has identified the most critical shortfalls of the Army's logistics environmental program and recommended practical solutions. It is now being used as the ODCSLOG's "road map" in developing a more effective HAZMAT management strategy. Recommendations concerning needed policy changes and procedure changes are being implemented. It's recommended system concept was the major factor in the successful drafting of an Army functional description for a HAZMAT tracking system. That functional description has been staffed with the MACOMs and is now being used as the Army's input to the development of a DoD tracking system under the Defense Environmental Corporate Information Management (DECIM).

10. Study sponsor: Office of the Deputy Chief of Staff for Logistics (ODCSLOG).

11. Performing organization and principal author:

a. Organization - Logistics Operations, Inc. (LOI) under management by Martin Marietta Energy Systems, Inc. for the U.S. Department of Energy.

b. Task leader/principal investigator: Mr. Peter L. Mentis

12. DTIC accession number of final report:

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14. Start and completion dates of study: Start - Jan 91; Complete - Jan 92.

GIST Sheet

Logistics Assessment of Propulsion Alternatives for the Advanced Field Artillery System (AFAS)

THE PRINCIPAL FINDINGS

(1) Throughout the analysis of propellant alternatives for the AFAS, packaging was found to be the key to logistics benefits.

(2) Efficient packaging of both Unicharge and Liquid Propellant (LP) can lead to a potential logistics benefit, when compared to bag charges, in the areas of handling, transportation, manpower requirements, storage and cost.

(3) LP provides potential advantages over Unicharge due to its relative packaging efficiency.

THE MAIN ASSUMPTIONS

(1) A full-up AFAS system is in place including the AFAS-Cannon (AFAS-C), FARV-Ammunition (FARV-A), Palletized Loading System and manpower requirements.

(2) The ammunition resupply concept modelled was assumed to be representative of a future AFAS resupply scenario.

(3) A hybrid packaging solution was assumed for LP that includes discrete containers from the Load, Assemble and Pack plant to the FARV-A and bulk resupply (pumping) at the FARV-A and from the FARV-A to the AFAS-C.

(4) The AFAS was assumed to fire 337 rounds per tube per day in a wartime scenario.

THE PRINCIPAL LIMITATIONS

(1) All Unicharge and LP packaging parameters considered in this analysis are conceptual in nature.

(2) Packaging designs for LP and Unicharge have not been finalized during the time period in which this study was conducted.

THE SCOPE OF THE STUDY

(1) The scope of the study addressed the logistics impact to the combat service support system, factory to foxhole, of advanced propulsion alternatives for the AFAS.

(2) Areas of analysis included: impact of the propulsion decision on the design of the AFAS; whether conversion is for all battlefield artillery or only selected pieces; impact of having powder and LP in the same Division or Corps at the same time; force structure impacts, including military occupational specialties and training; hazardous material implications, including demilitarization, crew and handling safety precautions; relative cost of propellant and handling methodologies, including packaging, handling, storage, transportation and transportability.

THE STUDY OBJECTIVE: To perform an independent assessment of logistics considerations that will affect the AFAS propulsion decision. Propulsion alternatives under consideration for use with the AFAS include Unicharge and LP.

THE BASIC APPROACH

(1) Define the logistics resupply concepts for the AFAS.

(2) Determine the packaging concepts for each propellant alternative.

(3) Determine the impact of each packaging alternative on the logistics resupply system and related logistics elements and issues.

(4) The impact of packaging alternatives on the logistics resupply system was modelled using the Artillery Resupply Simulation (ARTREARM). ARTREARM was used in the analysis of MHE, transportation and personnel requirements for each alternative.

(5) The analysis was supported by logistics panel consisting of personnel from the Project Manager - Ammunition Logistics; U.S. Army Ordnance Center and School, U.S. Army Combined Arms Support Command; U.S. Army Transportation School; U.S. Army Ordnance Missile Munitions Center and School; Project Manager - Future Armored Resupply Vehicle; and the U.S. Army Field Artillery School.

THE REASON FOR PERFORMING THE STUDY: This effort was performed in response to a tasker by the Operations and Plans Division, Office of the Deputy Chief of Staff for Logistics (ODCSLOG), Department of the Army.

THE STUDY IMPACT: The results of the analysis were used as input to the ODCSLOG position on the selection of Unicharge or LP for the AFAS Advanced Technology Transition Demonstrator.

STUDY SPONSOR: Headquarters, Department of the Army (DALO-PLP), Washington, D.C. 20310-0521

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS: U.S. Army Materiel Systems Analysis Activity, John Conolly, Wilson Heaps

DTIC ACCESSION NUMBER: Report available by contacting AMSAA's Reports Processing Center, DSN 298-4661.

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START AND COMPLETION DATE OF STUDY: The study began in January 1991 and was completed in September 1991.

Scenario Analysis for Combat Systems Study Gist

The Reason for Performing the Study was to develop an analytical approach to conduct cost and effectiveness trade-offs among the Army's combat systems; and to determine system mixes that ensure the warfighting edge under budget and personnel reductions.

The Principal Results were (1) the development of the scenario analysis approach that integrates cost and effectiveness under uncertainty; (2) the development of a linear programming model, called the Brigade Mix Model, that determines appropriate mixes of combat systems that meet the challenges of the future; (3) a fast and transparent tool that has the flexibility to accommodate a wide range of operational and empirical information and provide insights into the system mix issue.

The Main Assumption of the study was that the computer combat battles were representative of the battles a brigade would expect to encounter, and that operational and empirical information used in the approach have linear properties within the solution space. Other assumptions are presented in the report as they pertain to specific examples.

The Major Restrictions of the study were the number of CASTFOREM computer combat model battles available at the brigade/battalion level and the systems played in these battles.

The Scope of the Study was limited to brigade level units located in the European and Southwest Asian theater of operations for the examples presented. However, the approach has potential applicability for higher level units and for other geographical locations.

The Study Objective was to develop an analytic approach that would provide insights into the combat system mix needed for the Army of the future operating under uncertainty and with significant reductions in budget and personnel.

The Basic Approach of the study was to implement the scenario analysis technique in conjunction with several ongoing system studies conducted at TRAC-WSMR. These studies include the Army System Modernization (ASM) Cost and Operational Effectiveness Analysis (COEA), the tubed launched, optically sighted, wire guided (TOW) Sight Improvement Program COEA, Legal Mix VII Study, and the Armor Antiarmor White Paper. In all these studies, the implementation of the scenario analysis approach followed the same general outline. First a pictorial representation in tree structure of the problem was developed. The scenario analysis tree represented probable avenues of future events envisioned for the unit (normally a brigade) being developed. Each event could simply be one battle, similar to a first battle analysis, or a series of battles, such as a campaign analysis. Second, operational data for the systems in each of the battles were analyzed and aggregated from appropriate CASTFOREM battle runs. The operational data included lethality, firing rates, and survivability of the BLUE systems, as well as the threat laydown. Cost and personnel data were gathered from past studies and appropriate agencies. Third, a linear program was developed that represented the scenario analysis tree. The program was run to integrate the resources and effectiveness

results to determine the mix of combat systems needed. The constraints for the linear program would incorporate all measures of effectiveness, provisions for BLUE tactics and doctrine, and force structure requirements. Fourth, sensitivities were conducted by running many "what if" cases in the linear program. Comparisons between the base case and these sensitivities were made, and significant changes were reported.

The Study Sponsor was the US Army TRADOC Analysis Command, ATRC, Fort Leavenworth, KS 66027-5200.

The Study Proponent was the US Army TRADOC Analysis Command - White Sands Missile Range, ATRC-W, White Sands Missile Range, NM 88002-5502.

The Analysis Agency was the US Army TRADOC Analysis Command - White Sands Missile Range, ATRC-WDB, Resource Analysis Directorate, White Sands Missile Range, NM 88002-5502. Point of contact is Richard Laferriere, DSN 258-1494.

The Battle of 73 Easting

Study Gist

The Reason for Performing the Study. To determine where we stand in model development in terms of the acquisition, direct fire, movement, terrain, and data assessments.

The Principal Results. There is an extremely high correlation between the actual results of the Battle of 73 Easting and the predicted results obtained by the Janus combat simulation.

- The Janus model demonstrates a significant sensitivity to the effects of weather, terrain, posture, and tactics that can be easily exploited.
- In a more complex battle, the divergence between actual and model results will most likely increase.
- If fielded to trainers, Janus will provide consistency between CD, training, and doctrinal development.
- Demonstrates criticality of the SIGHT advantage presently enjoyed by US ground forces.
- Provides a real world scenario for combat developments.

Assumptions. None.

Major Limitations. A considerable amount of precise real world data was not available for comparison. These included: which Blue weapon did the killing, range of each Blue engagement, dismounted Red positioning, and number of Red rounds fired by type.

Some of this data was available anecdotically. There were many anomalies and considerable uncertainty. Consequently, none of these data points were compared with model results.

The Scope of the Study. The study was limited to one well documented battle from Operation Desert Storm and one high resolution combat simulation - Janus(A). The study had as its main objective to compare the combat outcome of this well documented battle with the results obtained from a standard Army high resolution model.

The Study Objectives were to compare the combat outcome of a well documented Desert Storm battle with the results obtained from a standard Army high resolution combat development model.

To determine what changes are required in the model to make it more representative of actual combat.

Given a good correlation between model and the actual battle can be achieved, to determine the sensitivity of combat outcome to weather, terrain, tactics, and posture.

The Basic Approach. In October of 1991, the Center of Military History published a draft document detailed the execution and results of the Battle of 73 Easting. Using this document plus additional information provided by DARPA and IDA, the battle was recreated in the Janus model. Then using the combat development master data base presently in use, the battle was run eight times in Janus.

The results of the simulation were then compared to the results provided by the field data collection team. After this comparison was completed and the excellent correlation obtained, the study was broadened to examine the effects that weather, terrain representation, tactics, and defender posture would have had on this real world battle.

The Study Sponsor was the US Army TRADOC Analysis Command, Fort Leavenworth, Kansas.

The Study Proponents: None.

The Study Agency was the US Army TRADOC Analysis Command - White Sands Missile Range, Fire Support Directorate. Points-of-Contact are Mr. Robert Washer, DSN 258-7066 and Mr. Barney Watson, DSN 258-4298.

The Study Impact. For the first time, was now have a mark on the wall as to where we stand in terms of high resolution model development. After ten years of effort it appears that basic model architecture, data, and combat phenomenology has been correctly applied. In simple battles Janus accurately predicts battle outcome. We now have a rather good feeling that we can use this model in future studies with a high degree of assurance that its predicted results can be excepted with few reservations. We also know, that our past work over the last five years in terms of studies has not been deprivated.

V Corps VARS STUDY GIST

1. Study title. V Corps 2000 Automated Redistribution System (VARS), an automated decision support system.

2. Principal findings.

a. VARS accesses the HQDA Requirements Validation (REQVAL) Plus database (the output from the CBS-X/Daily Distribution Execution System), to include POMCUS and INTRANSIT (validated requisition) materiels, and allows users to view the assets of a given unit/ major subordinate command/theater in several management perspectives. Users may view equipment in terms of authorized, on-hand, substitute, in-transit, overages, and shortages at any level of command at any time in the program. The data may be viewed or printed in tabular and graphical presentations.

b. Along with providing a user friendly display of the REQVAL database, VARS assists answering "what if" questions concerning the reallocation of REPORTABLE equipment among units in the Corps/ theater geographical area for which unit data is available. VARS provides the ability to perform various "what if scenarios" and answer questions such as "who has ...?," "where do I need ...?," "where can I get ...?"

(1) VARS can simulate the redistribution of equipment to and from units when units are downsized, inactivated, notionally created, or upon MTOE changes.

(2) VARS can provide optimal redistribution orders to "pure fleet" units (to reduce the number of NSNs for each LIN); the potential savings is in the quantity and training of mechanics, the quantity of special tools, and the quantity and complexity of PLL.

(3) VARS can be used to conduct trade-off analyses among units to achieve optimal equipment availability condition ratings.

c. Equipment may be "moved" from any level of command to any other level and the results of the moves are displayed in graphical format. The output graphs provide visual displays of modeling and facilitate making conclusions and recommendations. The model prints redistribution orders in materiel management activity formats.

d. User selected options (toggles) are available to simulate various conditions, making the model extremely flexible (paragraph 7e).

e. VARS was not and is not designed to replace any existing products or methodologies.

3. Main assumptions.

a. The Army Authorization Documentation System (TAADS) represents the true equipment quantity authorizations of all units (the model provides the user with the ability to modify the authorized equipment quantities).

b. The REQVAL database is accurate and current and reflects the true equipment quantity status of all units. This implies that all units provide timely inputs through the CBS-X system.

c. The listing of NSNs in Supply Bulletin 700-200 is in the priority order of fill (the model provides the user with the ability to alter the NSN order for each LIN).

d. The program will be installed on the secure computer that "taps into" the REQVAL database (although the program is not classified, the REQVAL database is classified SECRET).

4. Principal limitations.

a. UPDATES: VARS operates exclusively with REQVAL. Should the REQVAL database maintained at G4 not be updated in synchronization with 19th CMMC (REQVAL is updated to USAREUR weekly by HQDA), the data presented may not necessarily agree. VARS MUST BE REGENERATED WITH EACH REQVAL UPDATE due to the massive number of indexes that are updated. The data is only as current as CBS-X/REQVAL users in the field keep the database.

b. ALO: VARS does not tie into the USR reporting system; equipment readiness is not addressed. Users have the option to specify fill and turn-in levels (as a percent of authorized equipment) by unit.

c. VISIBILITY: VARS accesses only the REQVAL database, but not information contained in other SUPPLY oriented databases maintained at various levels in USAREUR.

d. HARDWARE: VARS requires an IBM compatible computer (286/386/486) with at least 512 KB of internal memory (640 is highly recommended). VARS may require up to 70 MB of hard disk space to store indexes and temporary work files (storage space is dependent on the number of units represented in the computer). The speed of the computer and the average seek time of your hard disk will affect the performance of VARS. For sites above brigade level a 386/33 or 486 class computer will signifanctly increase the throughput of VARS data displays.

e. Units affiliated with an MSC are displayed differently than by traditional chain of command. Units input supply transactions to one of several Tactical Army Combat Computer System (TACCS)

point in the program. VARS was developed using commercial software packages to process and present data. The output is presented in graphical and tabular forms, all of which can be printed to assist with analysis and to provide records and reports.

b. VARS uses existing databases as its primary input. This saves time and resources for collecting and updating data, ensures consistency of study results among users and related analyses, and reduces the criticism of "inventing your own data" to achieve desirable results. If the user has done no MODELING or CROSSLEVELING the quantities shown are real world according to the REQVAL database. The two primary input databases are:

(1) TAADS - contains the types and quantities of authorized equipment.

(2) REQVAL - contains the quantities of onhand, substitute, and intransit equipment (down to the NSN level).

c. Simulated movement of equipment can be controlled by several options, such as prescribing unit priorities and levels of transfer and fill.

d. Output graphs, containing before and after modeling attributes, constitute the primary medium from which analyses can be conducted. Paired bars are used for each unit. The left bar represents the authorized quantity of equipment and the stacked right bar represents on-hand, substitute, and in-transit equipment. Prior-to modeling quantities are represented by triangles, diamonds, and squares. The "real analysis" is conducted by comparing output graphs of several equipment redistribution alternatives.

e. This program makes use of Supply Bulletin 700-200 for LIN, NSN, GROUP, CLASS, and the Army Federal Supply Catalogue information; appendix H allows substitution logic to be accurate. VARS always fills units using a standard methodology, Pacing items, followed by ERC A, B, and C items. The user can preset five fill levels and five transfer levels and toggle functions ON/OFF. The options control the following functions:

(1) Substitute (ON/OFF): Allows/prevents filling of substitute LINs if not enough "real" LIN equipment is available.

(2) Intransits (ON/OFF): Allows/prevents filling of validated requisitions if not enough "real" or substitute LIN equipment is available.

(3a) Distance (ON): Fills equipment by the closest item to receiving unit in unit priority order VS first item available in the "depot."

(3b) Distance (OFF): Equitably distributes equipment to all units in the priority specified by the user.

boxes. These TACCS (collection) boxes follow MSC "lines" to a great degree. However, because there are limited geographical collection points, there will be non-MSC affiliated units associated with each MSC shown in VARS. However, VARS now allows users to realign units to appropriate MSC.

5. Scope of the study.

a. The original intent was to include all reportable equipment for V Corps units.

b. Midway through the model development LTG Maddox noted that for long-term planning purposes he needed to know what equipment was available in POMCUS and Theater Reserves. Access to these databases was obtained and this equipment pool is now included in the model.

c. The model contains the logic to process the entire Army given force structure listing (with UICs) and supporting equipment databases (pargraph 9b).

6. Study objective(s).

a. To provide a data source to logistic staff personnel in user-friendly formats depicting equipment distributions by unit; quantities of authorized, on-hand (actual LINs), substitutes, in-transits (valid requisitions), overages, and shortages; and NSN, LIN, class, group, and commodity.

b. To provide a modeling tool to rapidly determine equipment redistribution solutions in today's drawdown/unit closure environment.

c. To determine the transportation cost (in terms of miles/ minutes travel) and the extent of "shuffling" required to pure fleet units.

d. To conduct analyses of equipment distribution alternatives to improve the ALO equipment fill status of critical units and to increase the number of units that meet readiness condition levels for equipment availability.

e. To provide the ability to create notional units, modify existing unit equipment MTOEs, and reflag units to discover equipment shortages months/years in advance. This will permit holding equipment of drawdown units and early identification of future equipment needs.

7. Basic approach.

a. VARS is a computer program which enables users to model various equipment redistribution options at user-selected levels. VARS has been designed to be user friendly with pull-down menus and pop-up selection boxes. Keyboard entries are not required at any

f. VARS was designed to operate on an IBM compatible computer rather than a main frame. Typically REQVAL users have personal computers.

8. Reasons for performing the study.

a. In May, 1991 LTG Maddox charged the V Corps ORSA cell to produce a program that would allow limited "what if" analyses of equipment redistribution. The Commanding General envisioned the primary users of the program to be himself, the Chief of Staff, and the G4. The program was to be developed for limited modeling and as an information display system.

b. There were two primary drivers for LTG Maddox tasking the development of VARS.

(1) He was unable to provide a quick response of specific unit shortages to an expeditious equipment offer by the CINC prior to Desserts Storm; V Corp lost the opportunity to obtain the much needed equipment.

(2) With the pending drawdown environment from the new peace conditions in Europe, he needed a tool to rapidly assess redistribution alternatives from units closing down and leaving behind extremely large quantities of equipment.

9. Study Impact.

a. VARS is a powerful tool that assists staff personnel in analyzing equipment redistribution alternatives rapidly and meticulously using HQDA data and policies. VARS can save enormous time and effort for planners and provide rapid, responsive recommendations to decision makers.

b. In May 1992, General Ross, the CG AMC, was provided a briefing on VARS. In June he concluded that VARS will "serve as the redistribution model required for the current DDES and REQVAL+." On 18 August the program was formally passed to AMC/SIMA for adoption into DDES/REQVAL for use on this HQDA world-wide equipment tracking system.

10. Study sponsors. LTG David M. Maddox, former CG, V Corps, and LTG Jerry R. Rutherford, CG, V Corps.

11. Performing organization and principal author(s).

a. Performing organization: V Corps ORSA Cell, Frankfurt, GM.

b. Authors: LTC Steven H. Pate
Mr. Thomas D. Knopp
Mr. Bassam M. Doughman
Mr. D. Larry Tolin

12. DTIC accession number. See attache DD Form 1498, submitted on 28 September 1992.

13. Comments and questions may be sent to:

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b. LTC Steven H. Pate/Mr. Larry Tolin

c. DSN 320-7591/6364 or commercial 011-49-69-151-7591/6364.

14. Start and completion dates of study. August 1991-July 1992.

ABSTRACTS OF THE DR. WILBUR B. PAYNE MEMORIAL

AWARD FOR EXCELLENCE IN ANALYSIS 1992 PAPERS

1992 DR. WILBUR B. PAYNE AWARDS FOR EXCELLENCE IN ANALYSIS

The group award, presented by Mr. Walter W. Hollis, Deputy Under Secretary of the Army (Operations Research) at a ceremony during the 31st Army Operations Research Symposium, Fort Lee, VA and a subsequent ceremony at the US Army Concepts Analysis Agency, Bethesda, MD, went to the CAA Value Added Analysis Study Team.

The Concepts Analysis Agency was tasked by the Director, Program Evaluation and Analysis, HQDA, to develop a method of determining the Value Added of candidate equipment modernization programs to the effectiveness and efficiency of the Army. The study team designed a modular structure for carrying out the analysis and applied a prototype of the method to the FY90-97 Army program. Enhancements and expansions of the method led to applications for the FY94-99 program. The result was an analytical support capability that became a basic component of the Long-Range Research, Development and Acquisition Plan review and the POM building process. The analysis produces feasible acquisition strategies and system mixes, expected financial expenditures over the planning periods, life cycle cost estimates as a function of procurement quantities, and evaluations of resultant force effectiveness--all in a timely and responsive fashion.

Results of the many analyses carried out were presented at the most senior levels of the Army, including the Secretary, the Chief and Vice Chief of Staff, and the Executive Select Committee on Modernization.

Among the analytic advances made by the study team were:

A method to quantify and include subjective factors affecting senior level decisionmaking;

An automated costing method that quickly computes life cycle costs at the Baseline Cost Estimate or Army Cost Position levels of detail. The method is in a spreadsheet format for use by action officers;

A response surface method, derived from hundreds of combat simulation runs, to evaluate contributions of candidate systems to force combat effectiveness and to estimate force effectiveness of particular systems mixes, and

A mixed integer programming model that considers nonlinear economy of scale costing effects in determining optimal acquisition strategies.

For their success, professionalism, dedication, and analytical excellence, the members of the CAA Value Added Analysis team are the recipients of the 1992 Dr. Wilbur B. Payne Memorial Award. The team consisted of: LTC Robert R. Koury, Study Director; COL John B. Harrington; LTC Andrew G. Loerch; LTC James N. Richman; LTC Rodney K. Stuart; MAJ David C. Brown; MAJ Robert Clayton; MAJ

The individual award, was presented by Mr. Hollis, at the ceremony during the 31st Army Operations Research Symposium, Fort Lee, VA, to Mr. Richard R. Laferriere, TRAC-White Sands Missile Range, for his work summarized in the paper *Scenario Analysis for Combat Systems*, TRAC-WSMR-TR-92-023.

An urgent need was identified, during the course of several studies, for a method to conduct cost and effectiveness trade-offs among Army combat systems and to determine the best mix of systems to maintain the Army's fighting edge. Mr. Laferriere extended, enhanced and used "scenario analysis" to this end. Coupling today's pressures to reduce military expenditures with volatile and dynamic regional contingency military requirements makes such an analytic capability specially important.

Scenario analysis is an optimization technique for distributing resources over several planning periods. It has been used in portfolio optimization applications. The method has been enhanced to apply to combat system tradeoffs. The method involves the characteristic of uncertainty by identifying possible events ("scenarios") and assigns probabilities of expected occurrence based on the relative importance of the events. The more scenarios used, the more robust the solution. A structured optimization model is used to determine the decision that results in the best performance. The best decision is based on all the scenarios and constraints used, and the stated objectives.

The approach is presently in use in the Brigade Mix Model, applied to several TRAC-WSMR studies. Included are the Army System Modernization and TOW Sight Improvement Program COEAs, the Legal Mix VII study, and the Armor Antiarmor White Paper.

For the far-reaching utility and flexible application of his innovative analysis, Mr. Laferriere was awarded the 1992 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis.

Gregory A. Post; CPT George A. Broadnax; CPT William F. Mann, III; CPT Stephen E. McGuire; CPT Patrick M. Williams; Ms. Ola C. Berry; Ms. Judith A. Bundy; Ms. Linda A. Coblentz; Ms. Linda C. LaBarbera; and Messrs. Daniel A. Citrenbaum, Karsten G. Engelmann, Joel S. Gordon, Duane E. Gory, Peter W. Norman, Richard G. Poulos, Ronald P. Reale, and Steven B. Siegel.

The basic papers comprising the work of the team are: *Army Program Value Added Analysis 94-99, Volume I - Main Report*, CAA-SR-92-10; *Army Program Value Added Analysis 94-99, Volume II - Appendix F*, CAA-SR-92-10 SECRET-NOFORN-WNINTEL; *Value Added Analysis: LRRDAP General Officer Review Quick Reaction Analysis*, CAA-MR-92-24; *Value Added Analysis: Chief of Staff Offsite Review Quick Reaction Analysis*, CAA-MR-92-25; *Value Added Analysis: LRRDAP Analysis Planning Session Quick Reaction Analysis*, CAA-MR-92-26 CONFIDENTIAL; *Value Added Analysis: Analysis of Modernization Alternatives at Various TOA Levels to Include a Low Risk Option*, CAA-MR-92-27; *Value Added Analysis: Secretary of the Army Modernization Questions*, CAA-MR-92-29; and *Value Added Linear Optimization of Resources*, CAA-TP-92-1.